HEALTH STATUS FOLLOWING TRAUMATIC INJURY

Short Title: Health status after injury

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INTRODUCTION

Traumatic injury is the leading cause of death in Australians aged less than 45 years and causes more than 5% of all admissions to hospital.[1] The ongoing effects of injury have been shown to impact on all aspects of a person's life,[2] including compromised physical[3-6] and psychological functioning.[4, 6-11] The economic consequences of injury are also substantial. Rates of return to work following severe injury are variable, but approximately 50% of patients have not returned to work within five years.[9, 12, 13] Of those who do return to work, many have considerable difficulty retaining employment and meeting the social and performance demands of the workplace.[14] The associated decline in social networks after traumatic injury contributes to poor mental health,[15] enhancing the likelihood of poor outcomes. This cyclical interaction affects both psychosocial and economic outcomes following injury. Most importantly, injured patients have greater post-discharge health service utilization than that of the general population, with this increased usage continuing for up to 50 years post-injury.[16] Thus, the injured population has the potential to contribute least to the economy, but cost most in terms of service provision.

Although much research has confirmed the high incidence of poor outcomes following traumatic injury, these same studies have also confirmed that approximately one quarter to one half of individuals do not experience problems.[3, 4, 9] There have been various attempts to predict which individuals will recover rapidly from injury and, conversely, which individuals will continue to experience health status compromise on a medium or long-term basis.[3, 5, 17] However, little of this research has been based on a complex predictive model, which is likely to provide greater accuracy and explanatory ability.

To develop a model, it is relatively clear that demographic factors such as age and educational level, as well as injury and acute care factors such as location and severity of injury and length of hospital stay (LOS), are likely to predict outcome in the injured population.[3-5, 12, 18] Yet much of the variation in long-term outcome in the injured population remains unexplained. Recent research has shown that the inclusion of post-acute variables may help to explain more of the variation in recovery after injury.[5, 7, 12, 13, 17] For example, physical, cognitive and social functioning was related to disability two years after injury,[13] illness representation predicted health-related quality of life (QOL) three months[17] and six months post-injury,[19] and self-efficacy predicted post-injury return to work.[12] In addition, self-appraisal of the impact of the trauma and level of vocational productivity were associatied with physical health and life satisfaction 6-15 years post-trauma[20] and low levels of depression and an optimistic life orientation, as well as low injury severity scores, predicted return to work at 12 months post-injury.[21] Availability of emotional support, including family support[22, 23]and the ability to self-care (i.e. greater independenct in physical functioning) have also been proposed as potentially modificable factors that affect recovery after traumatic injury.[6, 23] However, little is known about the trajectory of these factors over time. To date, few post-acute care factors have been examined thoroughly, despite the potential utility of these variables. In light of this, this study aimed to: (i) describe the health-related QOL of injured adults requiring admission to hospital over time; and (ii) explore the relationships between health status, demographic, injury and acute treatment variables and post-acute factors, such as patients' perceptions about the supportiveness of their environment, their illness and their ability to self-care. Importantly, this study sought to capture some of the

psychosocial and health-related complexity of the recovery process following traumatic injury.

MATERIALS AND METHODS

A study using a prospective cohort design of patients aged 18 years or over was undertaken with recruitment extending from May 2006 until November 2007. Two hospitals (one tertiary referral hospital and one teaching hospital) in South-East Queensland, Australia participated in the study.

Participants

Consecutive adults (≥18 years) were invited to participate in this study if they met the inclusion criteria of (i) admitted to a study hospital for ≥24 hours for the acute treatment of injury (allocated an ICD-10-AM code: S00 – S99, T00 – T35, T63, T66 – 72 or T 75 – 77) (ii) anticipated to have an Injury Severity Score (ISS) of ≥9, (iii) able to provide consent for themselves and (iv) able to complete the first questionnaire prior to hospital discharge. Patients were excluded if they were (i) transferred within 24 hours to another ward for unrelated treatment or remained an inpatient for more than 24 hours due to causes other than acute treatment of injury, (ii) were injured as a result of hangings, poisonings and other injuries not caused by force (e.g. pathological fracture) or (iii) were unable to participate in follow-up questionnaires (e.g. prisoner, overseas resident).

Data Collection

Potential participants were approached during their hospitalization to gain their consent. Once consented, participants were approached as near to the time of

discharge as possible to complete initial data collection. All participants were subsequently forwarded a self-administered questionnaire by mail and then contacted by telephone to obtain the results of the questionnaire at both three and six months post hospital discharge. This combination of mail and telephone contact was designed to provide participants with time to consider their answers to each question while optimizing follow-up rates by not relying on questionnaires being returned via the mail. Up to five attempts to contact participants were made at each of the follow-up points.

Data were collected from multiple sources including the participants, their health care records and the Queensland Trauma Registry (QTR). The timing for each data point was informed by the theoretical basis of the concept, in other words when the characteristic was most likely to change, while balancing participant workload (Table 1). The outcome variable for this study was health status as measured via the Medical Short Form (SF-36)[24] and the proposed predictor variables included: demographic details (age, sex, marital status, work status, household income, highest educational level); injury characteristics (mechanism of injury, body region with most severe injury, ISS, place where injury occurred); acute care factors (length of Intensive Care Unit (ICU) stay if relevant, LOS, underwent surgery); and post-acute factors (illness perceptions, perceived support and self-care ability).

[INSERT TABLE 1]

Post-Acute Factors

Illness Perceptions: The Revised Illness Perception Questionnaire (IPQ-R) was used to determine participant's beliefs about the controllability of their illness.[25] The IPQ-R incorporates three sections, the first of which consists of yes/no questions regarding commonly experienced Identity symptoms and the relationship of these symptoms to

their injury. These Identity symptoms should be tailored to the population being studied, therefore this study used the 10 Identity symptoms related to the trauma population. The second section of the IPQ-R contains 38 Likert scale questions (scale of one to five) related to seven subscales including timeline (acute/chronic, six items), consequences (six items), personal control (six items), treatment control (five items), illness coherence (five items), time cyclical (four items) and emotional representations (six items).[25] Higher scores indicate more positive beliefs or a sense of being more in control of their injury and its consequences. The third section, the Causes subscale, was not used in this study. The timing for measurement of illness perceptions in this study was based on the authors' assessment that it is not until weeks to months after hospital discharge that people start to consider their situation and make appraisals of their circumstances, hence data were collected at three months. The theoretical underpinnings of illness perceptions support this as it is expected that it will take some time for individuals to develop both a cognitive and an emotional understanding of their illness. There has been limited exploration of the role illness perceptions play in recovery after traumatic injury, with inconsistent relationships identified in small cohorts.[26-28]

Perceived Support: The extent to which participants' perceived that they had access to services/information, support and the opportunity to control their circumstances was assessed using the Information Autonomy and Support Scale (IAS).[29] This scale measured perceived access to information (three items), perceived dependency and control i.e., autonomy (three items) and perceived support (four items), and has previously been identified as predicting QOL.[29] Responses were provided on a five-point Likert scale ranging from one: 'definitely true' to five: 'definitely false', with

higher scores indicating lower perceived access to information, autonomy and support. The scale has been used extensively in multiple sclerosis populations.[29]

Self-Care: The Therapeutic Self-Care Scale (TSCS)[30] (12 items on a six-point Likert scale from zero = 'not at all' to five = 'very much so') was used to determine the participant's perceptions of their knowledge about their health and associated treatment and resultant learning needs.

The primary outcome variable for this study was health status six months post hospital discharge, specifically the Physical Component Summary (PCS) score and the Mental Component Summary (MCS) score, as measured by the SF-36 version 2r; an instrument that measures health status across eight domains or sub-scales and is well validated in many different populations in both the acute and chronic setting to measure health status.[24] Higher scores on each of the subscales and summary scores indicate better health status. The baseline questionnaire, which participants completed during their hospitalization, directed participants to rate their health status 'prior to their injury'. Both three and six month questionnaires directed participants to rate their current health status.

Approval to conduct this study was gained from the Human Research Ethics Committee's (HREC) of the participating hospitals and university. All participants provided informed consent prior to data collection and were free to withdraw from the study at any time. The routine operation of the QTR is approved by the HRECs of all participating hospitals and The University of Queensland, and is recognized within the provisions of the Health Legislation Amendment Regulation (no. 7) 2006 under the Health Services Act 1991 (Queensland) for the purpose of collection data.

Statistical Analysis

All analyses were conducted using Stata 10 (Statacorp, Texas). Data were cleaned and checked for missing and outlying values. Descriptive characteristics of the population were explored. Wald statistics and resultant p values were obtained using univariate mixed model analysis with the PCS and MCS scores used as outcomes variables. Norm-based scores are reported for all sub-scale and component scores of the SF-36. Significant (alpha 0.1 level) variables were included stepwise in multivariate models.

Linear mixed effects models were used to obtain the estimate coefficients of predictors of the PCS and MCS scores over the three time-points using the between patient variability as the random effect, allowing for a random slope at each time-point. Mixed effects models use all available data and allow for a correlation of errors caused by missing data to build a robust model. Likelihood ratio tests were performed at each step of the multivariate model building. All variables were assessed for transformation and interaction effects. In other words, all variables that were significant on univariate analysis were entered into the model stepwise with likelihood ratio tests run after each step. If variables were measured at multiple time-points, all measures were entered into the model with changes over time incorporated into the analysis. Where variables were not significant using the likelihood ratio test, they were removed from the model and the next variable entered and tested. Differences were considered significant at the $\alpha = 0.05$ level.

RESULTS

Two hundred and twelve injured patients consented to participate in the study, although 18 patients were excluded due to changes in their diagnosis or dying prior to hospital discharge thus 194 patients constituted the study cohort (Figure 1).

[INSERT FIGURE 1]

The majority of participants were male, in a stable relationship and averaged just under 40 years of age (Table 2). Other demographic characteristics are displayed in Table 2. Participants who completed six-month data collection were similar to those who did not complete data collection in regard to ISS, hospital LOS, marital status and income at baseline. However, those who completed six-month data collection were significantly older than those who did not complete data collection (mean age 47 versus 38 years, p= 0.002), indicating a greater loss of younger participants at follow-up.

[INSERT TABLE 2]

Although an attempt was made to predict ISS at the time of hospital admission, and only enroll those anticipated to have an ISS ≥9, 56 (28.9%) of the patients had a final ISS <9. Slightly more than 40% of participants were injured in road traffic related events and one third of participants were injured in a fall. Half of all injuries were in the lower extremities of the participant's body (Table 3). Patients spent an average of 8.5 days in hospital for acute treatment of their injury. Only 9% of patients required admission to ICU, with a short ICU LOS of three days. A majority of patients required surgery during the acute treatment of their injury (Table 3).

[INSERT TABLE 3]

Participants indicated that at six months post-discharge they generally felt confident about their ability to access information regarding their injury, but less confident in relation to their perceived autonomy and support. These levels of confidence were not significantly different from baseline [Information: mean (sd) 1.9 (1.0); Autonomy: 2.2 (1.0); Support: 2.5 (1.0)]. This confidence in accessing information is reinforced by the high score on the TSCS six months post-discharge indicating that study participants felt they understood the impact of their injury, had

good knowledge of the medications and other treatment they required and were able to perform regular activities and obtain help when required. Again, this had not changed from three months post-discharge (mean 4.3, sd 0.6). Illness perception was measured three months after discharge from hospital. Participants generally had a weak positive belief regarding their ability to control their injury and its consequences (see Table 4).

[INSERT TABLE 4]

The majority of participants reported experiencing a range of symptoms three months post-discharge, with pain (n = 113, 93%), fatigue (n = 87, 72%), stiff joints (n = 101, 84%), sleep difficulties (n = 81, 67%) and loss of strength (n = 102, 84%) each being reported by more than half the cohort.

In comparison to the general population, participants reported low health status scores, with scores being lowest at three months post-discharge from hospital (PCS and MCS at three months statistically below baseline, $p<0.001$). There was a slight improvement in scores in most sub-scales by six months post-hospital discharge, although these scores still remained below the levels participants' retrospectively reported as their pre-injury health status (Figure 2).

[INSERT FIGURE 2]

Few of the identified demographic, injury, acute care or post-acute variables were predictive of either the PCS or the MCS in this cohort of injured people (Table 5). Specifically, only age, the body region containing the most severe injury and the perceived consequences of injury subscale of the IPQ-R were predictive of PCS. As age and the perceived consequences of injury increased, PCS decreased (i.e., poorer health status). Each increasing year of age resulted in a decrease of 0.26 on the PCS score. Injuries to all body regions except the spine were predictive of higher PCS

scores when compared to injuries to the lower extremities, indicating that lower body injuries resulted in poorer physical health status. In relation to the MCS, only age, gender and perceived ability to control one's environment (scored on the autonomy subscale of the Information, Autonomy and Support Scale) predicted outcome. In contrast to PCS, as age increased, MCS also increased by 0.11 for each year of age. Males reported MCS scores almost four times higher than females. Greater levels of perceived ability to control one's environment predicted increased MCS (Table 3).

[INSERT TABLE 5]

DISCUSSION

This cohort study with six-month follow-up was conducted in a moderately injured group of patients. All patients required admission to hospital for ≥24 hours but, importantly, less than a quarter of the patients were considered to have experienced major injury as categorized by ISS. Furthermore, half of the cohort experienced injury to their lower extremities, which had the potential to create problems associated with mobility in their home and work environments, yet lower extremity injury did not predict health status.

Health status of participants prior to injury in this cohort was similar to Australian norms. These health status ratings had dropped markedly by three months post-hospital discharge in all subscales, with ratings improving slightly by six months post-hospital discharge but not returning to baseline levels. Although measures of health status have been used in other injured cohorts, these have focused on severely injured patients.[3, 31-33] In contrast, more than 75% of the cohort reported here experienced minor or moderate injury (ISS ≤15). This represents a timely reminder that patients with anatomically minor injuries can also experience ongoing compromise after hospital discharge and require ongoing support mechanisms to

assist their return to pre-injury health status. Recognition of this problem, by both clinicians and researchers, is required to ensure interventions are developed to meet the needs of all injury patients regardless of the severity of their injury.

More than half of the patients reported ongoing symptoms including pain, fatigue, stiff joints, sleep difficulties and less strength three months post-hospital discharge. Although there are many reports of the prevalence of pain as an element of health status, only one report of this broad range of symptoms in the general trauma population could be located,[19] where similar levels of ongoing symptoms were identified in this Taiwanese cohort of patients with moderate to severe injury. Despite this limited body of work, some additional understanding of some of the symptoms is possible due to inclusion of some of the symptoms in broader measures. Using the pain or discomfort dimension on the Euroqol 5D, more than half of patients with major injury (ISS>15) or injury that required admission to ICU reported pain or discomfort up to two years following injury.[3, 34, 35] More specifically, the presence of pain was investigated in one cohort of more than 3,000 moderate to severely injured patients,[36] where approximately two-thirds of patients reported chronic pain related to their injury 12 months after injury and pain at three months was predictive of the presence and severity of pain at 12 months. Importantly, pain was significantly correlated with poorer physical functioning in a cohort of 171 major burn injury patients.[37] These various results suggest the patients with the greatest potential for benefit from intervention could be identified in the short term after hospital discharge to enable early interventions to commence and that effective treatment may influence functional recovery.

No specific reports of sleep disturbance in the general trauma population in the months following hospital discharge could be located. However, sleep disturbance has

been reported in more than half of a small group of 60 chronic traumatic brain injury patients.[38] In addition, disrupted sleep is a component of post-traumatic stress disorder (PTSD) and, given the high incidence of PTSD during the months to years after hospital admission for serious trauma, this may provide explanation for some of the sleep disturbances reported in this cohort.[7, 9, 39] We did not assess for PTSD in this cohort with predominantly minor to moderate injuries (ISS≤15), so it is not possible to determine any relationship between sleep disturbance and PTSD, but further investigation of this issue is warranted.

The relationship between ongoing pain, fatigue, sleep disturbance and loss of strength is potentially important, with the majority of patients reporting that they experienced all of these symptoms. If these symptoms are interdependent, then the possibility that effective pain management would have the effect of improving sleep, reducing fatigue and facilitating exercise and other functional activities must be considered. This proposition should be tested in interventional studies.

Although participants demonstrated a positive belief on the IPQ-R regarding their ability to control the injury and its consequences, this belief was weak. The weakness may be influenced by the difficulty in controlling ongoing symptoms that many patients experienced, including pain, fatigue, stiff joints, sleeping problems and loss of strength. Illness perception has been examined in a group of 95 injured athletes who reported a much lower rate of symptoms than seen in our cohort (pain: 82%; loss of strength: 50%; stiff joint: 28%; fatigue: 28%). Despite these relatively low rates of ongoing symptoms, this group of athletes only reported a slightly more positive belief regarding personal control (mean 22.1, SD 4.6) and treatment control (mean 19.7, SD 3.4) than our cohort of injured patients admitted to hospital.[40] In another cohort of patients who had a traumatic injury, stronger beliefs regarding controllability were

reported in regard to illness representation, however the patients had experienced moderate to severe injury.[19]

These levels of control are in contrast to the high levels reported on the TSCS where average scores were above four out of a possible maximum of five indicating participants perceived they had good knowledge about their health care. This suggests that patients make a distinction between controlling their injury, which they feel only a small degree of control over, and taking care of themselves, which they feel a significant amount of control over. Indeed, the perception of having greater control over one's environment was significantly associated with improved ratings of mental health, confirming the importance of facilitating patients' ability to manage the impact of even minor to moderate injury on their lives.

In relation to health status, only two post-acute factors contributed to the prediction of outcome beyond the impact of age and injury. Specifically, greater perceived consequences of the injury were associated with poorer ratings of physical health and greater perceptions of control over one's environment were associated with better mental health. Although the direction of this relationship was not necessarily clear, the findings suggest that it may be important to focus on the perceptions patients have of their circumstances in the short-term following discharge. Overall, the findings have suggested that those at greatest risk of poor physical outcomes might be older patients with lower extremity injuries and more perceived consequences of their injuries, whereas those at greatest risk of poor mental health outcomes might be younger females with little perceived control over their environment. The principal of there being a relationship between illness representation and health status is consistent with that identified in the only other study that could be located that has examined this relationship in the trauma

population, [19] although further work is required to understand specific detail regarding the relationship.

A strength of this study is that it reports health-related QOL in a cohort of injured patients that rarely receives attention; specifically those predominantly with minor to moderate injury. However, a limitation of the study is that we were only able to recruit approximately one quarter of the patients who met the inclusion criteria and follow-up at six months was only 65%. This indicates some of the difficulties in following over time a group of patients who may be young, mobile and either relocate frequently or reside in group facilities that do not always have consistent phone and address contact details or otherwise be healthy so not have a consistent health care provider. This rate of follow-up is consistent with other studies conducted in the injured population in both Australia[7] and the USA,[31, 32] but falls short of the high levels of follow-up often achieved in European countries with effective nationwide address notification systems.[3, 8] Problems associated with follow-up were more pronounced in the younger age group enrolled in this study, resulting in an older group of participants completing this study than those who enrolled. This may have resulted in different results than those that might be reported by younger injured people and this limitation should be borne in mind when interpreting the results.

In summary, this study highlights that although patients may be considered to have a minor or moderate injury based on anatomical injury scoring systems, the ongoing impact for patients can be significant. Six months following injury, this cohort of predominantly minor to moderate injury patients report health-related QOL scores below their self-reported pre-injury scores and below the national norms. In addition, the majority of patients reported ongoing problems with pain, fatigue, stiff

joints, sleep disruption and loss of strength. Interventions aimed towards assisting recovery should not be limited to trauma patients with major injury.

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TABLE 1. Timing and Source of Data

Item	Source	Baseline	3 months	6 months
Demographic details	Patient	✓		
Injury characteristics	QTR	✓		
Acute care factors	Chart review	✓		
Revised Illness Perception Questionnaire	Patient		✓	
Information, Autonomy & Support Scale	Patient	✓		✓
Therapeutic Self-Care Scale	Patient		✓	✓
Quality of life	Patient	✓	✓	✓

QTR = Queensland Trauma Registry.

TABLE 2. Demographic characteristics (n = 194)

Variable	**Median (IQR)**
Age (years)	39 (29-56)
	Frequency (%)
Male	128 (66)
Marital Status	
Single	71 (37)
Married / Defacto	92 (48)
Divorced	15 (8)
Widowed	13 (7)
Unknown	3 (2)
Work Status	
Working	129 (67)
Retired	35 (18)
Student	8 (4)
Disability benefit	7 (4)
Unemployed	8 (4)
Other	7 (4)
Household Income ($AUD)	
< $20,000	32 (16)

$20,000 - $39,999	36 (19)
$40,000 - $59,999	36 (19)
$60,000 - $99,999	42 (22)
$100,000 - $119,999	14 (7)
≥$120,000	19 (10)
Unknown	15 (8)
Highest Educational Level	
Primary school only	8 (4)
Partial high school	52 (27)
Completed high school	54 (28)
Trade or vocational training	42 (22)
Diploma or Bachelor's Degree	32 (16)
Post-graduate Degree	6 (3)

$AUD – Australian Dollar

TABLE 3. Injury and acute care characteristics (n = 194)

Variable	Median (IQR)
ISS	9 (5-14)
Hospital LOS (days)	8.5 (5-15)
ICU LOS (days) (n = 17; 9%)	3 (1-8)
	Frequency (%)
Underwent surgery	140 (72)
Mechanism of Injury	
Road Traffic Crash	82 (42)
Fall	62 (32)
Collision	22 (11)
Other	28 (15)
Body region with most severe injury	
Lower extremity	97 (50)
Upper extremity	34 (18)
Thorax	23 (12)
Head, Face & Neck	23 (11)
Spine	10 (5)
Pelvis/abdomen	7 (4)
Place where injury occurred	

Home	44 (23)
Road	60 (31)
Work	23 (12)
Public Area	11 (6)
Other	56 (29)

ISS – Injury Severity Score; LOS – Length of Stay; ICU – Intensive Care Unit

TABLE 4. Post acute care characteristics (n = 194)

Variable	Mean (sd)
	3 months
Revised Illness Perception Questionnaire	
Timeline	18.8 (6.1)
(Possible Range: 6 – 30)	
Consequence	18.8 (6.4)
(Possible Range: 6 – 30)	
Personal Control	21.0 (5.8)
(Possible Range: 6 – 30)	
Treatment Control	17.2 (4.3)
(Possible Range: 5 – 25)	
Illness Coherence	19.8 (4.4)
(Possible Range: 5 – 25)	
Timeline-cyclical	9.4 (4.0)
(Possible Range: 4 – 20)	
Emotional representation	17.0 (6.4)
(Possible Range: 6 – 30)	
	6 months
Therapeutic Self-Care Scale	4.3 (0.7)

(Possible Range: 0 – 5)	
Information, Autonomy & Support Scale	
Information	1.8 (0.9)
(Possible Range: 1 – 5)	
Autonomy	2.1 (1.0)
(Possible Range: 1 – 5)	
Support	2.3 (1.1)
(Possible Range: 1 – 5)	

TABLE 5. Predictors of SF – 36 PCS Scores and MCS Scores six months post discharge

Variable	PCS Coefficient (95% CI); p value	MCS Coefficient (95% CI); p value
Age	-0.26 (-.0233 - -0.19); <0.001	0.11 (0.03 - 0.19); 0.01
Body region with most severe injury		
Lower extremity**		
Head, Face & Neck	6.52 (2.29 - 10.376); 0.003	
Thorax	3.46 (-0.39 - 7.13); 0.08	
Pelvis/abdomen	6.16 (0.81 - 11.51); 0.02	
Spine	0.61 (-5.31 - 6.51); 0.84	
Upper extremity	5.64 (2.49 - 8.79); <0.001	
Gender		
Female**		
Male		3.72 (0.964 – 6.79); 0.018
IPQ-R Consequences Subscale	-0.61 (0.79 –0.42); <0.001	
IAS - Autonomy Subscale		-3.39 (-5.43 – 2.44); <0.001

** Reference variable. PCS = Physical Component Summary Score. MCS = Mental Component Summary Score. IPQ-R = Revised Illness Perception Questionnaire. IAS = Information, Autonomy and Support Scale.